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Three-year study of elimination of laboratory work and the institution of large classes in general biology to provide room space for advanced courses and to reduce staff time. Student achievements in general biology were the same for both lecture-laboratory and lecture-only groups, with no differential achievement for different ability groups.

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IV-5

A Study of Problems Involved in Teaching Large Classes in College General Biology

JOHN BREUKELMAN, TED F. ANDREWS and JOSEPH D. NOVAK[1]

Staff and Facilities

As college enrollments continue to increase, many colleges will be faced with problems associated with lack of staff and facilities for teaching classes in biology. At the Kansas State Teachers College of Emporia, we found that our General Biology course required about half of our staff time and laboratory space was becoming a serious problem. In view of the impending need to reduce or eliminate laboratory work for the General Biology course, a three-year study was initiated to determine whether or not General Biology could be taught effectively in large lecture sections and without laboratory work. The study was conducted during 1955–57 with our General Biology course described elsewhere. (Breukelman, 1955).

Laboratory space has been limited at Emporia and it was necessary to operate several small biology laboratory sections for nearly all hours of the day and several evenings each week. This presented difficulties when preparations were necessary for other courses which used the same laboratories. The elimination of laboratory work in General Biology allowed for adequate room for the intermediate and advanced courses, which were also increasing in enrollments. Also, a substantial reduction in the per cent of the staff's time required in General Biology was effected. In Figure 1 we see that though enrollments had risen, staff time devoted to General Biology decreased when laboratory work was eliminated. Moreover, more than one-half time of one staff member was devoted to coordination of small lecture and laboratory sections, though this time was not figured into the staff load and thus does not appear in Figure 1.

Comparison of Classes

In order to obtain some indication as to whether or not the classes involved in the experiment were similar in ability, several entrance tests were used as criteria. These tests were given to students at the time they enrolled in college. Average scores were computed for each class for three entrance tests, i.e., the Biology Entrance test, the General Abilities test, and the English Composition test. When the six biology classes

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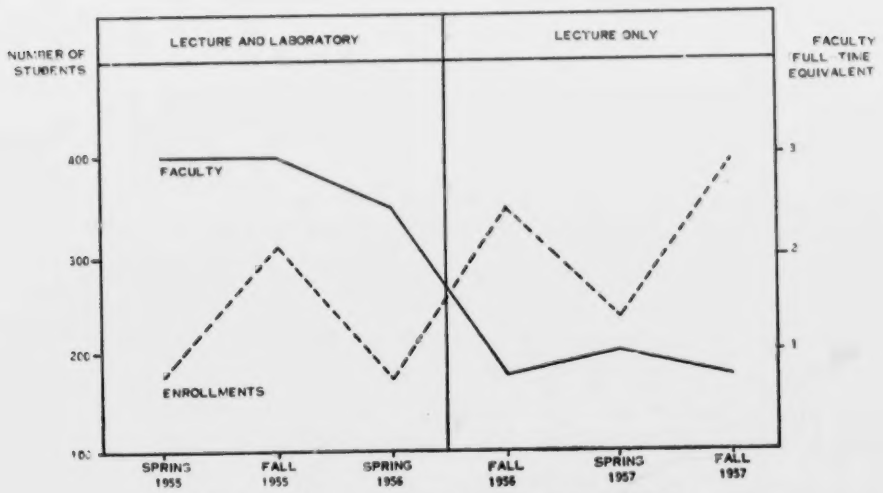

FIGURE 1. GENERAL BIOLOGY FACULTY AND ENROLLMENT FROM 1955–1957

involved in the study were compared, little difference in mean scores was found.

One class taught by the lecture-laboratory approach was compared with a class taught by the lecture method. Means were 56.00 and 58.73 for the lecture-laboratory and lecture-only groups, respectively, on the Biology Entrance test. For the General Abilities test, means of 101.68 and 101.33 were obtained for the lecture-laboratory and lecture-only groups, respectively. When the English Composition test was used for comparison, means of 90.48 and 94.56, were obtained for the lecture-laboratory and lecture-only groups, respectively.

The significance of differences in variances and means were tested to test the hypothesis that the groups did not differ in initial ability. The fall, 1955, lecture-laboratory group and the fall, 1957, lecture-only group were compared on each of the three entrance examinations. *t* and F values were obtained, none of which were significant. It was concluded that the two classes did not differ in initial ability, as measured by the tests used. The data are summarized in Table I.

Since the tests used in the General Biology course varied in length, it was not possible to compare class mean scores for the different semesters. Each score was converted into "per cent of total possible" score and these per cent-scores were used in the analysis of performance of students under the two methods of instruction.

Figure 2 shows the general decline in mean per cent-scores for each of the three performance groups and for the entire class over the three year period. This decline may have been due to the gradual elimination of test questions which were "too easy" as determined by item analysis.

Table I. Comparison of the fall, 1955 lecture and laboratory class with the fall, 1957 lecture-only group of three entrance tests.

Type of Instruction and Test	N	Mean Per Cent Score	Variance	Difference between Means	t	F
Lecture & Lab. Fall, 1955						
Biol. Ent.	25	56.00	103.75	.....	.....	.....
Gen. Abilities	25	101.63	304.40	.....	.....	.....
Eng. Comp.	25	90.48	629.33	.....	.....	.....
Lecture Only, Fall, 1957						
Biol. Ent.	104	58.73	109.65	2.73	1.17	1.057
Gen. Abilities	104	101.33	301.48	0.35	0.09	1.001
Eng. Comp.	104	94.56	502.45	4.08	0.80	1.252

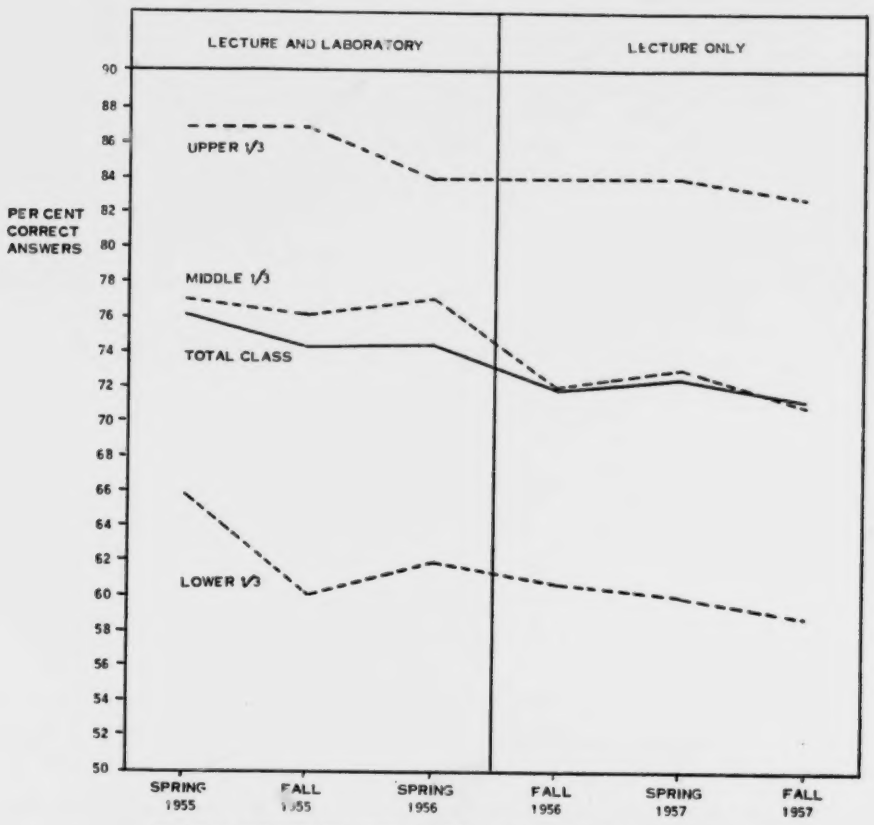

FIGURE 2. AVERAGE PER CENT-SCORES BY PERFORMANCE GROUPS AND BY TOTAL CLASS FROM 1955 TO 1957

The result of this practice would be a gradual decline in per cent-scores, even if students maintained constant achievement as regards the absolute amount learned. Data given below suggest that the decline in scores was due to elimination of "easy" questions. Most of the "easy" questions were removed after the first three semesters, and the general tendency for lower per cent-scores is less marked after this period. It should be noted that all three performance groups maintained about the same relative position over the three-year period. There is no indication that a differential effect on learning appeared in the three performance groups as a result of the elimination of laboratory work.

To check on the effect of removal of easy test items, a random sample of student's papers from the fall of 1955 class and the fall of 1957 class was obtained. These papers were rescored for total points obtained on 45 questions identical on the fall, 1955 tests and the fall, 1957 tests. The lecture-laboratory class, fall, 1955, had a mean score of 26.97 and a variance of 51.276. The lecture-only class, fall, 1957, had a mean score of 29.13 and a variance of 17.414. The difference in variance among the two classes was significant at the one per cent level. This would indicate that good students did somewhat better with laboratory instruction and poorer students learned somewhat less. The difference in means was tested by the Behrens-Fisher method (Johnson, 1949) and was found not to be significant. The data are summarized in Table II. These results are in general agreement with findings of other investigators working with somewhat different groups. (Cf. Cunningham's review, 1946).

Table II. Comparison of means and variances for fall, 1955 and fall, 1957 biology classes on 45 identical test items.

Group	N	Mean Score	Variance	Difference Between Means	d	F
Fall, 1955 (lecture & lab.)	30	26.97	51.276	.....	.....	.....
Fall, 1957 (lecture only)	30	29.13	17.414	2.16	1.429	2.945*

* Significant at the 1.0 per cent level.

When the per cent-scores were used in an analysis of difference in means and variance for the fall, 1955 and the fall, 1957 classes, an F value of 1.38 was obtained and it was concluded that there was no significant difference in variance between the group taught by the lecture-laboratory method and the group taught by the lecture-only

method. A t-value of 0.67 was obtained and we concluded that there was no significant difference between the mean per cent-scores of the group taught by the lecture-laboratory method and the lecture-only method. The data are summarized in Table III.

Table III. Comparison of means and variance for the lecture-laboratory and lecture-only classes on the biology course examinations.

Type of Instruction	Simple Size	Mean Per Cent-Score	Variance	t	F
Lecture-Lab. (Fall, 1955)	303	74.465	173.652	.. ....	.. ....
Lecture-Only (Fall, 1957)	104	71.423	125.401	0.67	1.38

Correlation Between Achievement and Ability

The Biology Entrance test has been used as a criterion for exempting students from the required General Biology course. It appeared desirable to know what correlation existed between entrance examinations and achievement in General Biology. Correlation coefficients were computed for three semesters for each of the three pretests and the total scores in General Biology. Reliabilities for the General Biology exams ranged from $r = 0.70$ to $r = 0.92$. Both the Biology Entrance test scores and the General Abilities test scores had reasonably good correlation with performance in General Biology, with r values in the range 0.60 to 0.68. The English Composition test was poorly correlated with achievement in General Biology with r values in the range 0.22 to 0.35. It should be noted that no conspicuous difference in correlation among the entrance tests and achievement exams occurred during the shift from lecture-laboratory to lecture-only instruction. The data are summarized in Table IV.

Table IV. Correlation Coefficients between total points obtained on biology exams and three entrance tests.

Type of Instruction and Semester	Biol. Total Points vs. Biol. Entrance Test	Biol. Total Points vs. Gen. Abil. Test	Biol. Total Points vs. Eng. Comp.
Lecture-Lab. (Fall, 1956)	.65	.62	.22
Lecture-Only (Spring, 1957)	.68	.60	.29
Lecture-Only (Fall, 1957)	.62	.60	.35

Summary and Recommendations

A reduction in staff time devoted to General Biology was effected through the elimination of laboratory work, though enrollments in the course have risen. Evidence is presented which suggests that students did not vary significantly in ability over the three-year period of the study. There was no evidence that students taught by the lecture-laboratory method varied in achievement in General Biology when compared with students taught by the lecture-only method. Also, there was no evidence of differential learning for high, low, or middle performance groups in the General Biology Classes. Correlation coefficients between entrance examinations and performance in General Biology were relatively constant under both methods of instruction, though none of the correlations were nigh.

A number of questions were not answered in this study and these should be carefully considered before laboratory work is eliminated from general biology courses. Some of the questions which require further study are:

1. What effect does elimination of laboratory work have on student attitudes toward biology?
2. What effect does elimination of laboratory work have on the development of attitudes required for success in biology, i.e., the "scientific attitude?"
3. What effect do large lecture sections and completely objective testing have on student's expression and development of original ideas?
4. What affect does elimination of laboratory work have on student's gain in ability to solve problems in science?
5. What is the effect of large lecture classes as compared with small lecture classes on student achievement in the respects noted above?
6. What effect do laboratory experiences have on the retention of biological facts and concepts?

The lecture-only approach apparently was effective in teaching biological facts and principles. We feel that several practices may have contributed to the success of the course and we recommend these to others who wish to "experiment" with large lecture sections.

1. Lectures must be carefully and thoroughly planned, then executed almost as a television performance.
2. Many hours per week must be set aside by the instructor as well as by student assistants to counsel and assist students.
3. The instructor in charge of a large class should have a much

reduced teaching load. Our practice was restrict staff load to 3 to 5 contact hours per week for instructors teaching the large biology class.

4. Not all instructors can be effective in teaching large classes. Instructors selected must have ability to establish rapport with students, as well as a real interest in teaching a large class.
5. Selected and sometimes locally produced audio-visual aids are needed.
6. Lecture outlines, life cycle diagrams, figures from texts, study questions, etc., should be mimeographed as "hand out sheets" to supplement the lectures and course text.

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